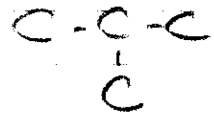
HOMEWORK #1

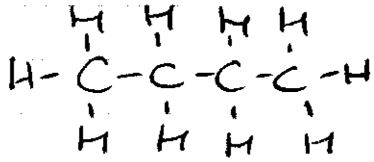
① (a) C_4H_{10}

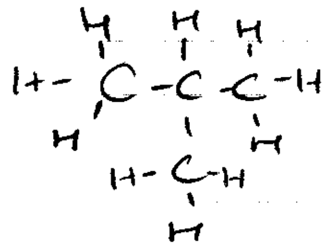
Two possible frameworks:

C - C - C - C

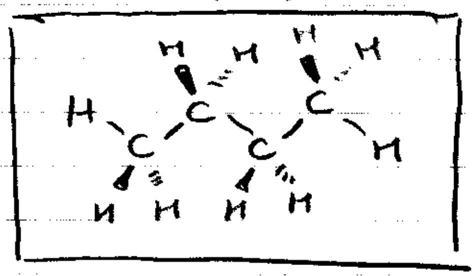


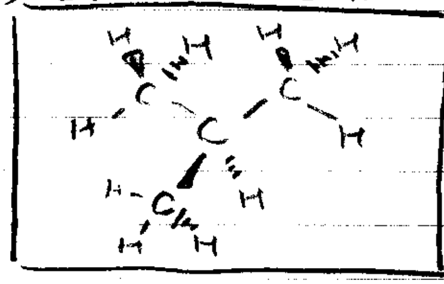
Satisfy octet for each C by attaching available H





Apply VSEPR to determine the shape -
All the C's have 4e⁻ groups, so they will be tetrahedral - all bond angles will be 109.°





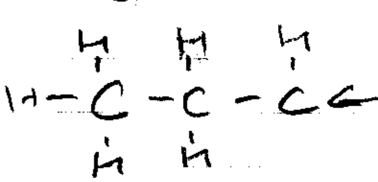
For chains of tetrahedral atoms easier to draw starting with a zig zag line of "in plane" bonds

(b) C_3H_6

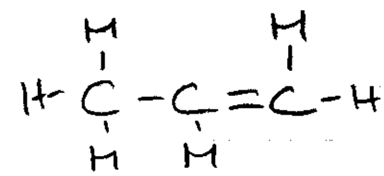
Only 1 possible framework:

C - C - C

Satisfy octet w/ H:



out of H w/o satisfying octet for this C means there has to be a multiple bond



Only possibility because of symmetry

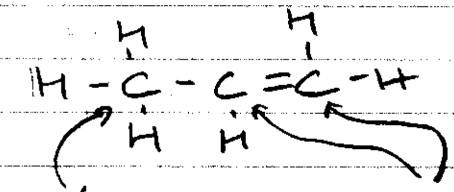
C = C - C

would give same result

HOMEWORK #1

① (b) cont.

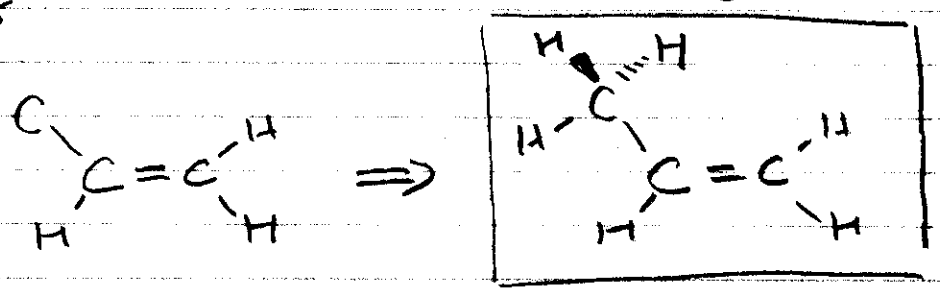
Apply VSEPR



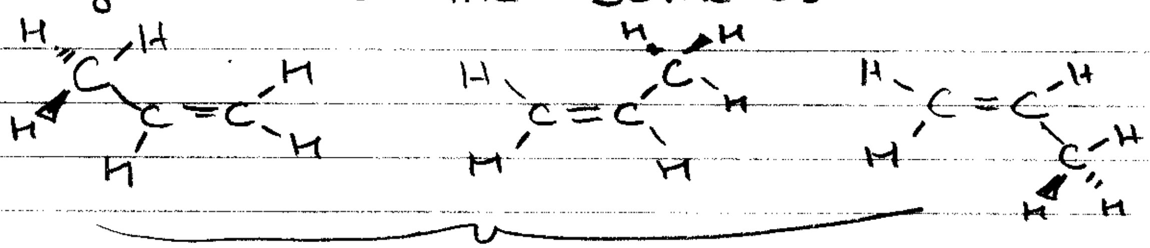
4 e⁻ groups tetrahedral 109° bond angle

3 e⁻ groups trigonal planar, 120° bond angles (∵ all bonds, single, double or triple just count as 1 e⁻ group)

Easiest to start drawing w/ trigonal planar atoms



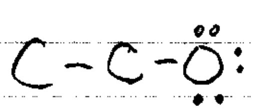
NOTE:
All of the following are the same structure because by simply rotating single bonds or the entire structure, you end up with a image that is the same as the one above



ALL THE SAME COMPOUND

(c) $C_2H_5O^-$

1 possible framework

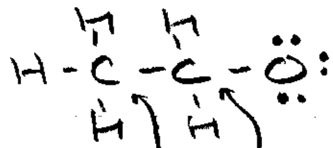


oxygen is most likely to have negative charge. This means "O^-" will have 7 valence e^- and this Lewis dot structure $\cdot\ddot{O}$: This tells you O has to be on the end because it can only form 1 bond.

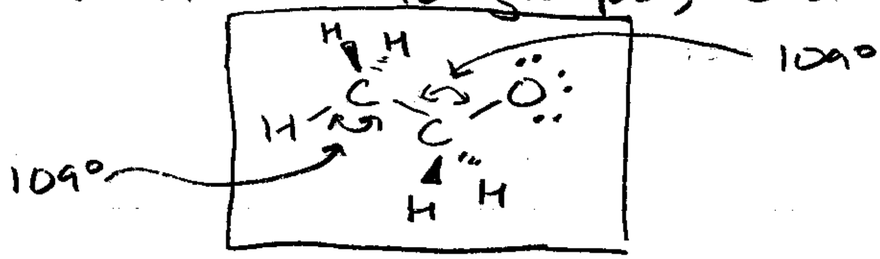
HOMEWORK #1

(1) (c) cont.

Satisfy octet by attaching H



VSEPR: 4e⁻ groups, tetrahedral, 109°

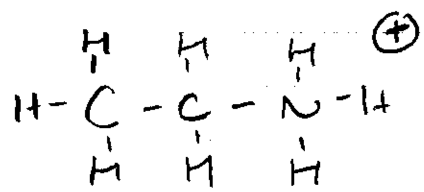


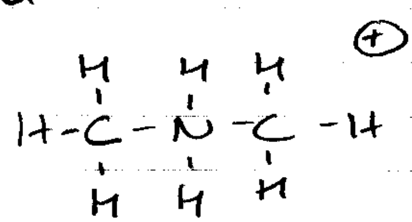
(d) $C_2H_8N^+$ nitrogen is most likely to have positive charge. This means N will have 4 valence e⁻ and this Lewis Dot structure: ·N· Tells you N will have 4 bond pairs, just like C.

Possible Frameworks:

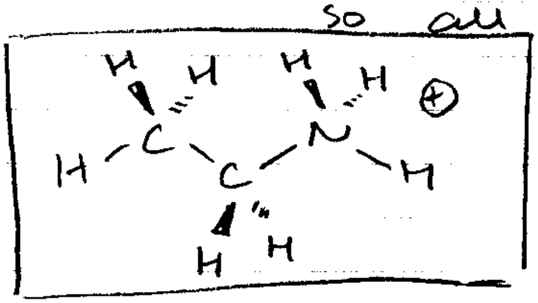
C - C - N   C - N - C

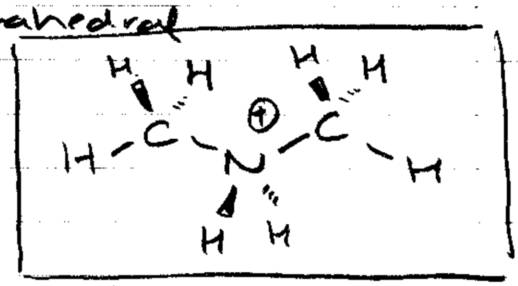
Add H to satisfy octet





VSEPR: 4 e⁻ groups about each C & N so all tetrahedral





HOMEWORK #1

(2) C_2H_3NO

O – C – N – C

⇓ adding lone pairs

:Ö – C – N̈ – C

⇓ add H ~~to satisfy octet~~

:Ö(–H) – C(H)(H) – N̈ – C

Short 4 H this time
for each 2 H you're short
will need to add 1 "pi"
bond – so in this case will
need to add 2 pi bonds

Possibilities for location of pi bonds

:Ö = C = N̈ – C   :Ö = C – N̈ = C

Other possibilities don't work because of lone pairs:

~~:Ö – C = N̈ = C~~   ~~:Ö ≡ C – N – C~~

10e⁻

~~O – C ≡ N̈ – C~~   ~~O – C – N̈ ≡ C~~

add H

Ö = C = N̈ – C(H)(H) – H   :Ö = C(H) – N̈ = C(H) – H

VSEPR:

2e⁻ groups linear 180°

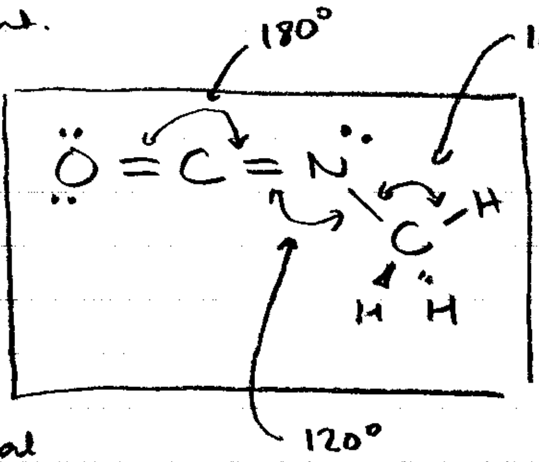
3e⁻ groups trigonal planar 120°

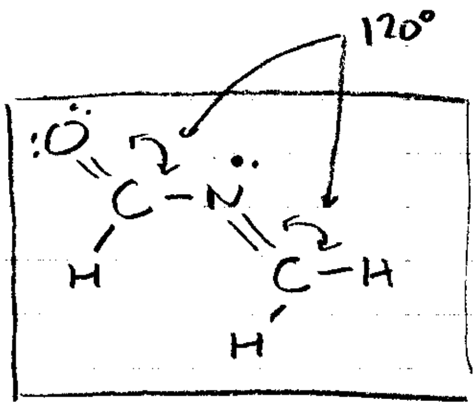
4e⁻ group tetrahedral 109°

all 3e⁻ group trigonal planar 109°

HOMEWORK #1

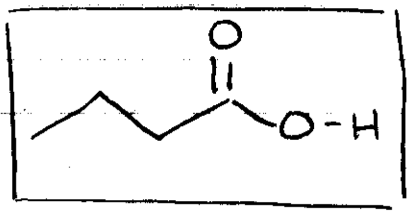
(2) Cont.



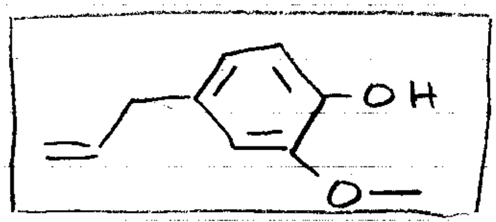


this is methyl isocyanate, an extremely dangerous compound responsible for 1 of the worse chemical accidents ever in Bhopal, India in 1980's. 100's of people were killed when this was accidently released from a chemical plant

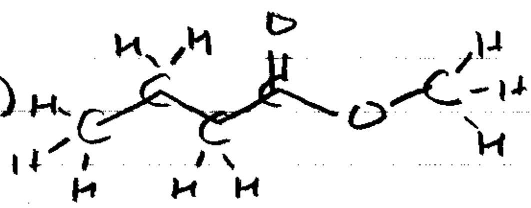
(3) (a)



(b)

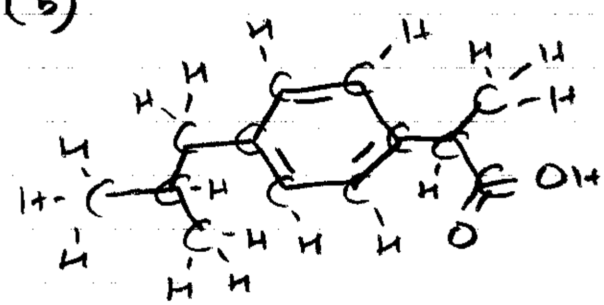


(4) (a)



$C_5H_{10}O_2$

(b)

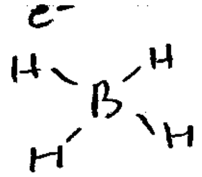


$C_{13}H_{18}O_2$

(5) (a) BH_4^-

works best to count valence e^- for inorganic compounds

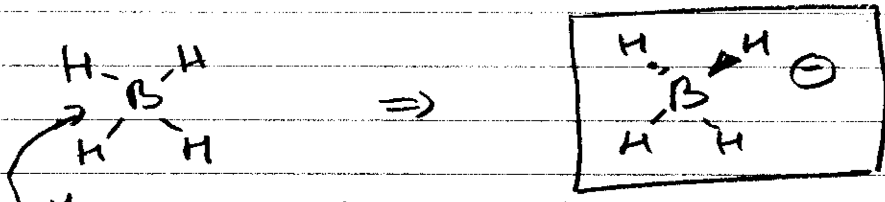
total valence e^- = 3 + 4(1) + 1 = 8 (B + 4H + (-))



$8e^- - 8e^- = 0$ for framework

HOMEWORK #1

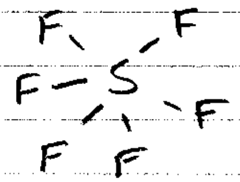
(5)



4 e^- groups, tetrahedral

(b) SF_6

total valence e^- = $\underset{S}{6} + \underset{6F}{6(7)} = 48$

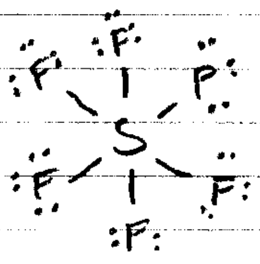


framework

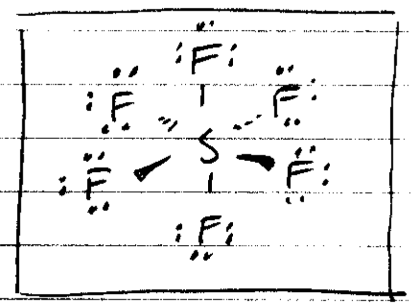
valence e^- remaining = $48 - 6(2) = 36 = 18$ e^- pairs

($6(2)$ for 6 framework bonds)

satisfy octet w/ remaining valence e^-



6 e^- groups so octahedral



(c) ICl_2^-

total valence e^- = $\underset{I}{7} + \underset{2Cl}{2(7)} + \underset{(-)}{1} = 22$

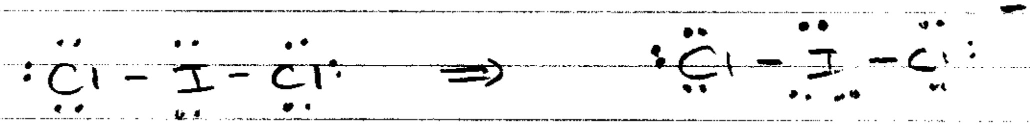
Cl − I − Cl

framework

remaining valence e^- = $22 - 4e^- = 18e^-$

($4e^-$ for 2 framework bonds)

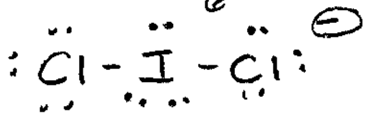
Satisfy octet



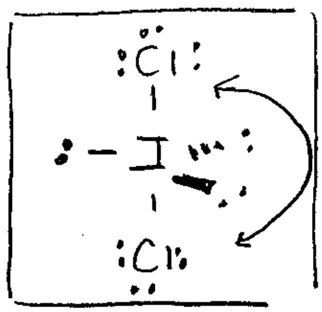
octet is satisfied but still have $2e^-$ remaining – put on central atom

HOMEWORK #1

(5) (c) cont.



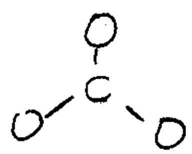
5e⁻ groups
so trigonal planar
put lone pairs in equatorial sites (trigonal plane)



Cl-I-Cl bond angle is 180°

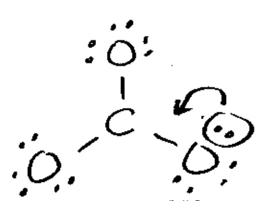
(6) CO_3^{2-}

	C	+ 3O	+ 2(-)		
total valence e^- =	4	+ 3(6)	+ 2	=	24

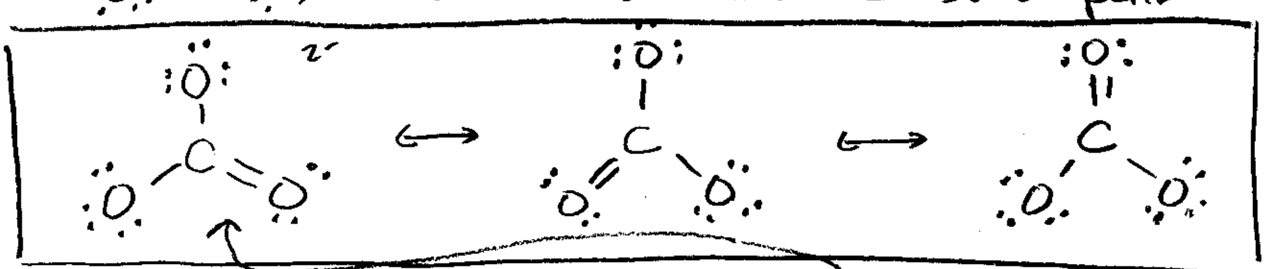


remaining valence e^- =
24 - 6 = 18

satisfy octet:



out of electrons and no octet on C, so move lone pair down to become bond pair

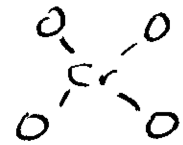


arbitrarily put double bond here - could have also put it between other O's & C - gives 2 other completely equivalent resonance forms.

HOMEWORK #1

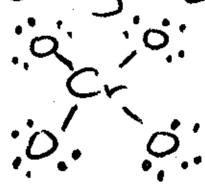
(7) CrO_4^{2-}

$$\text{total valence } e^- = \begin{matrix} Cr & + & 4O & + & 2(-) \\ 6 & + & 4(6) & + & 2 & = 32 \end{matrix}$$



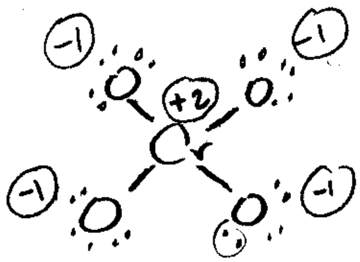
remaining e^- = 32 − 8 = 24

satisfy octet:



← Looks like you're done, but you're not. Need to take into consideration formal charges

(See pp 364 of your text for review)



Best Lewis structure will have a minimum number of formal charges. Can minimize number in this structure by moving lone pairs from 2 O's to form pi bonds w/ Cr.

This gives a structure with just 2 formal charges.

It does put more than an octet around Cr, but it's OK to have an "expanded" octet around elements on 3rd row or below of the periodic table.

can write 5 additional equivalent resonance structures